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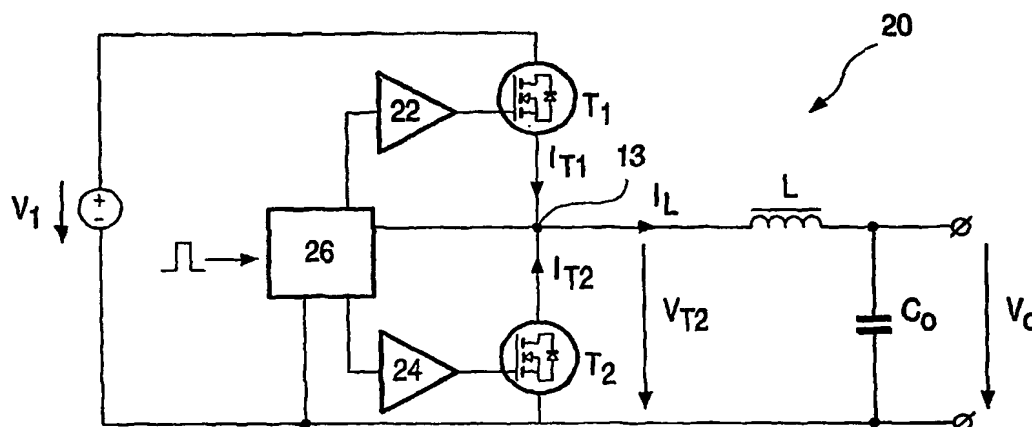
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[Continued on next page]

(54) Title: CONVERTER CIRCUIT AND CONTROL METHOD FOR SAME



(57) Abstract: In known converter circuits switching losses occur, which are caused by reverse-recovery currents of a freewheeling diode. To reduce said switching losses it is proposed by the invention to drive the switching elements such that, upon switching from the second to the first switching element, the timing is controlled in such a manner that the shoot through currents and the conduction of the freewheeling diode are kept at a low value or, better still, are precluded. As regards the control mechanism, it is proposed to turn on the first switching element later if shoot through currents occur, and to turn on the first switching element sooner if conduction of the freewheeling diode occurs. Here, a time of overlap may be provided during which both switching elements are simultaneously conducting. For the control mechanism, the voltage across a switching element can be used as a measured input value.

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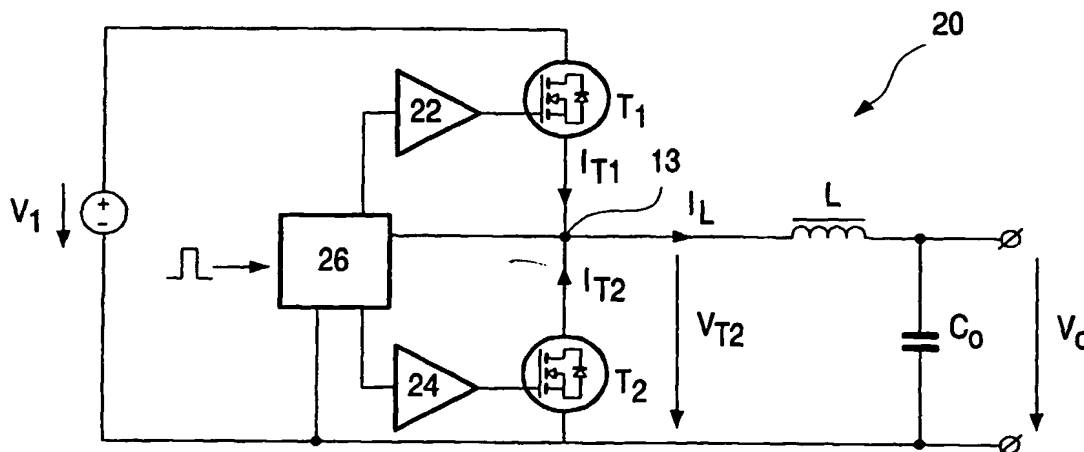
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CH, CY, CZ, DK, EE, ES, FI, FR, GB, GH, GM, GR, HU,
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ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO,

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SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

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A. CLASSIFICATION OF SUBJECT MATTER

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H02M1/00

13 MAR 2005

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 H03K H02M

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2001/036085 A1 (NARITA YUKI) 1 November 2001 (2001-11-01) cited in the application	1,2,10, 11
Y	paragraph [0013] - paragraph [0014]; figure 1	3,6
Y	US 6 396 250 B1 (BRIDGE CHRISTOPHER DAVID) 28 May 2002 (2002-05-28) cited in the application the whole document	3,6

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☒ Further documents are listed in the continuation of box C.☒ Patent family members are listed in annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search

2 December 2003

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25.03.04

Name and mailing address of the ISA

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INTERNATIONAL SEARCH REPORT

Inter Application No
P071B 03/03979

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	TSUKAMOTO K ET AL: "A HIGHLY EFFICIENT BUCK CONVERTER WITH DOUBLE-ANTI-CROSSOVER SYNCHRONOUS RECTIFICATION USING A NEWLY DEVELOPED CONTROL IC" PESC '98. RECORD OF THE 29TH ANNUAL IEEE POWER ELECTRONICS SPECIALISTS CONFERENCE. FUKUOKA, MAY 18 - 21, 1998, PESC. ANNUAL POWER ELECTRONICS SPECIALISTS CONFERENCE, NEW YORK, NY: IEEE, US, vol. 2, 18 May 1998 (1998-05-18), pages 1243-1247, XP001004299 ISBN: 0-7803-4490-1 page 1245 - page 1245 -----	1-6,10, 11
A	US 2002/105311 A1 (WHEELER NICOLAS J ET AL) 8 August 2002 (2002-08-08) -----	
A	US 5 408 150 A (WILCOX MILTON E) 18 April 1995 (1995-04-18) -----	

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IB 03/03979

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

1-6, 10, 11

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest.
- ☐ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-6,10,11

Converter circuit of the type comprising two synchronous switching elements and an inductive element, wherein a control device adjusts the switching dead time by determining whether shoot through current or freewheel current occurs based upon the voltage across the second switching element after turn-off.

2. claim: 7

Converter circuit of the type comprising two synchronous switching elements and an inductive element, wherein a control device carries out a parameter measurement during a first switching period in order to set the dead time of the switching elements in a second switching period.

3. claim: 8

Converter circuit of the type comprising two synchronous switching elements and an inductive element, wherein a control device sets an initial dead time of the switching elements at the onset of operation.

4. claim: 9

Converter circuit of the type comprising two synchronous switching elements and an inductive element, with reduced gate voltage driving phase.

INTERNATIONAL SEARCH REPORT

International Application No.
PCT/IB 03/03979

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
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